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(54) Abstract Title
Telecine systems

(57) A telecine system includes an optical collector 19 for redirecting light scattered by damage to the film 1 towards a photodetector. The optical collector may be a frusto-conical mirror.

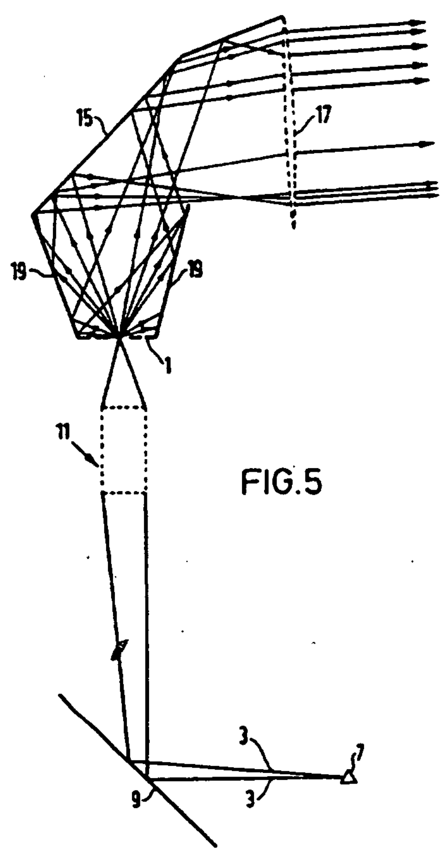

FIG.5

GB 2 323 495 A

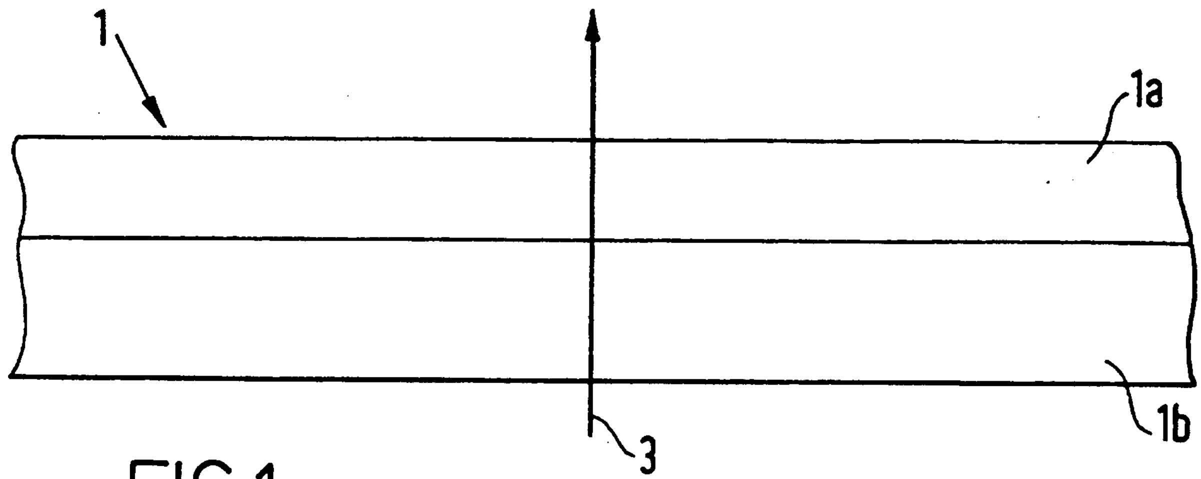

FIG.1

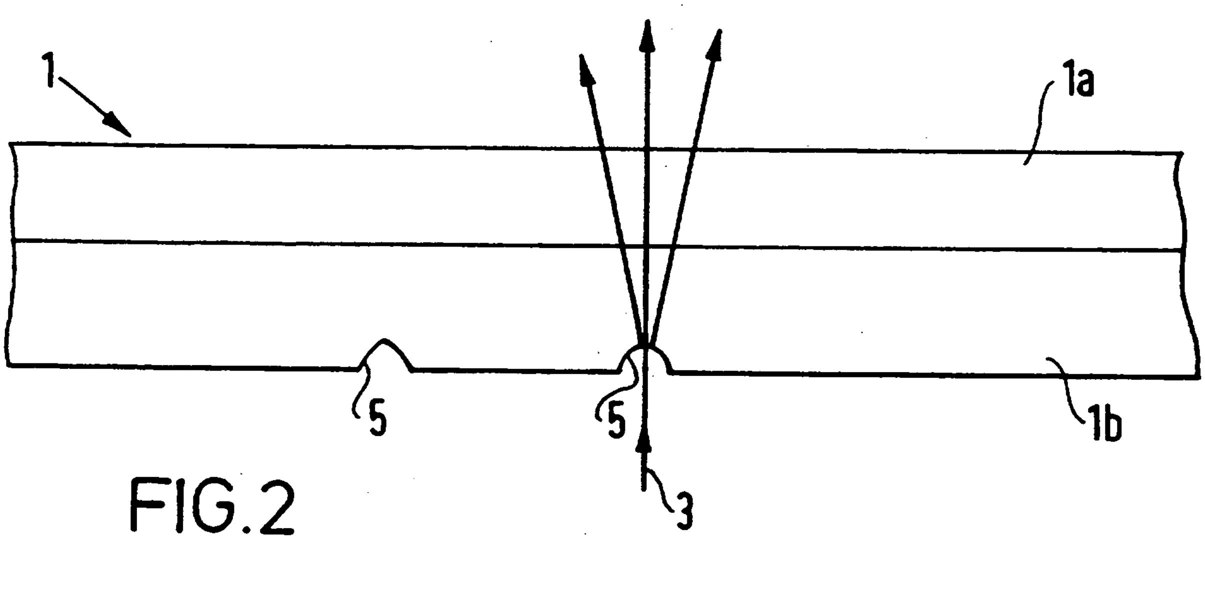

FIG.2

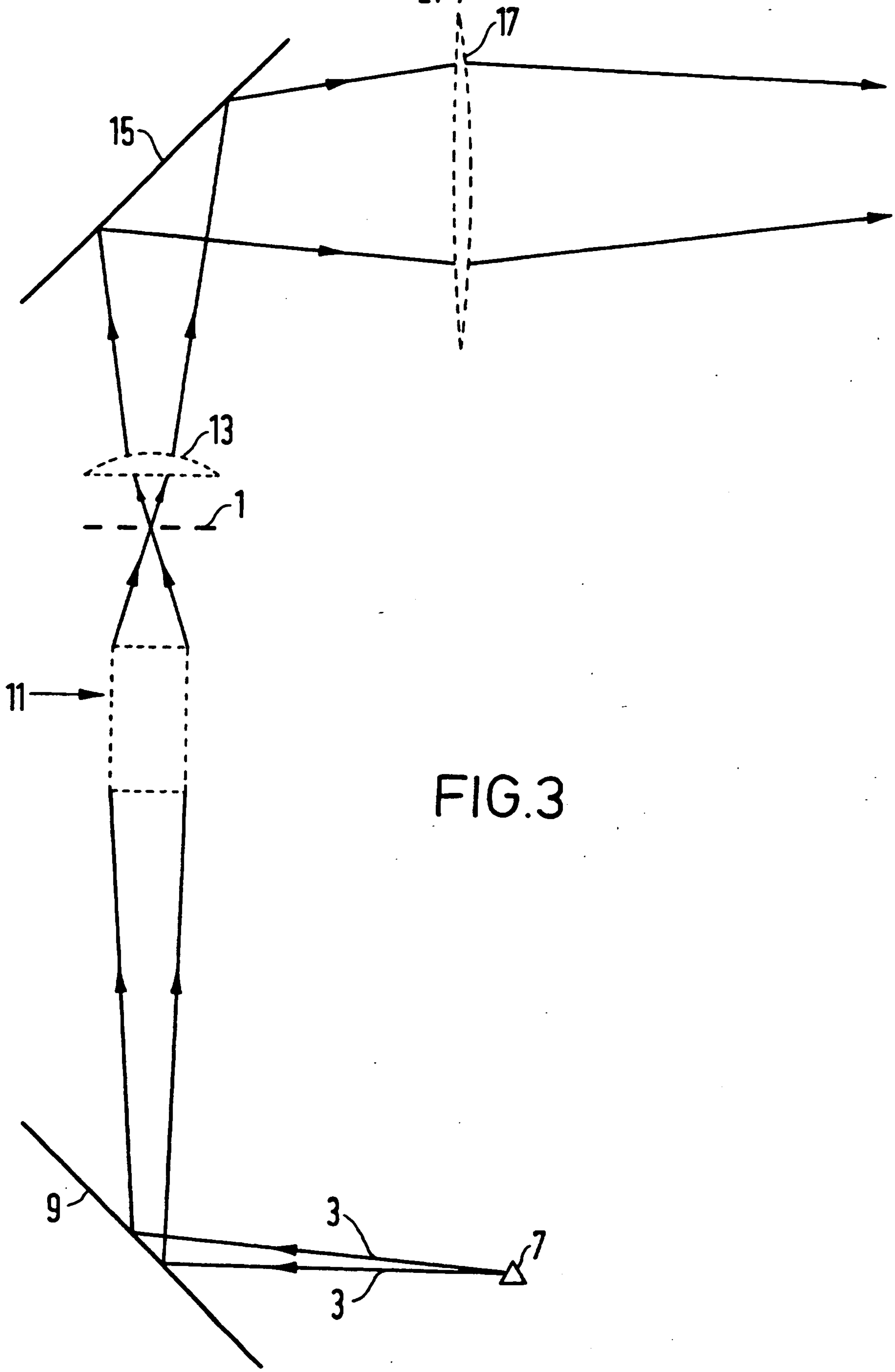

FIG.3

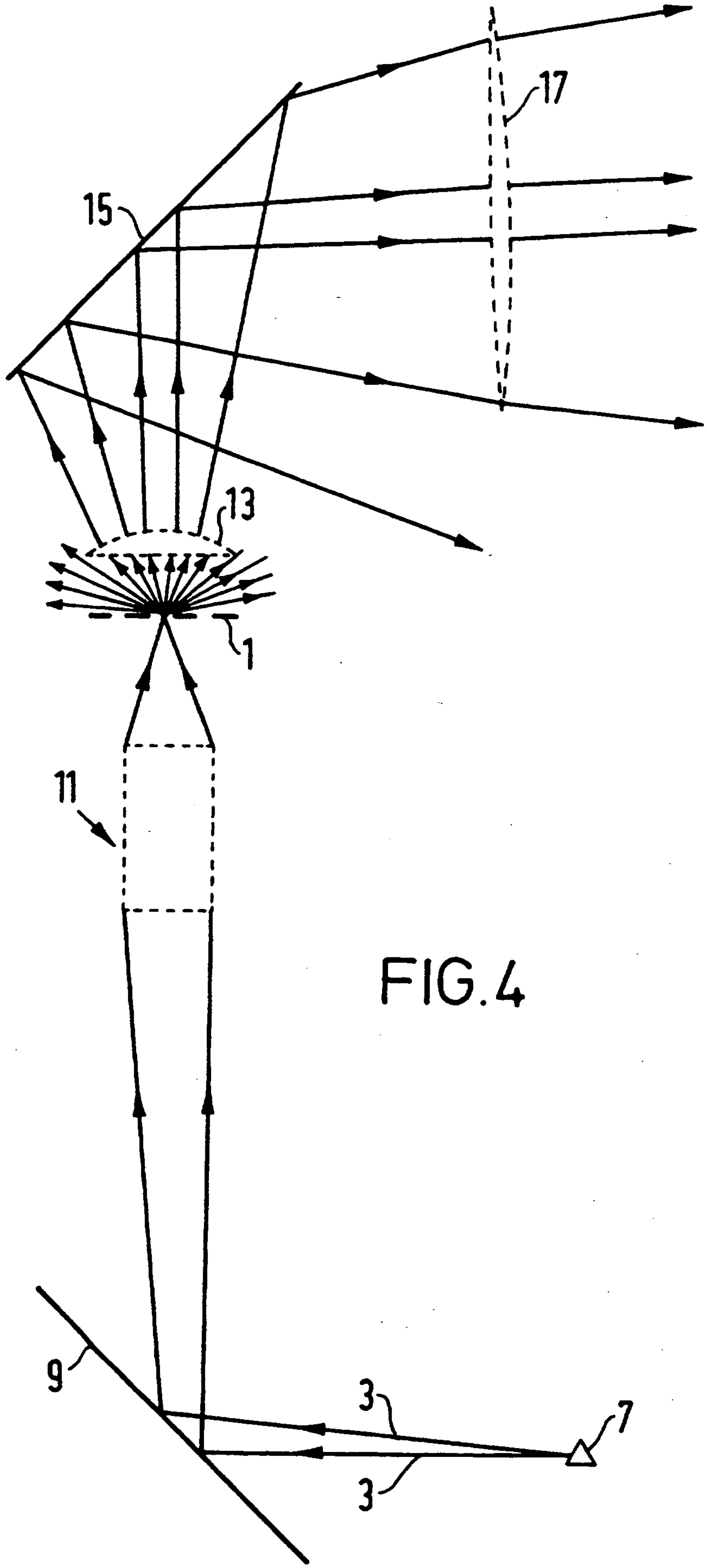

FIG.4

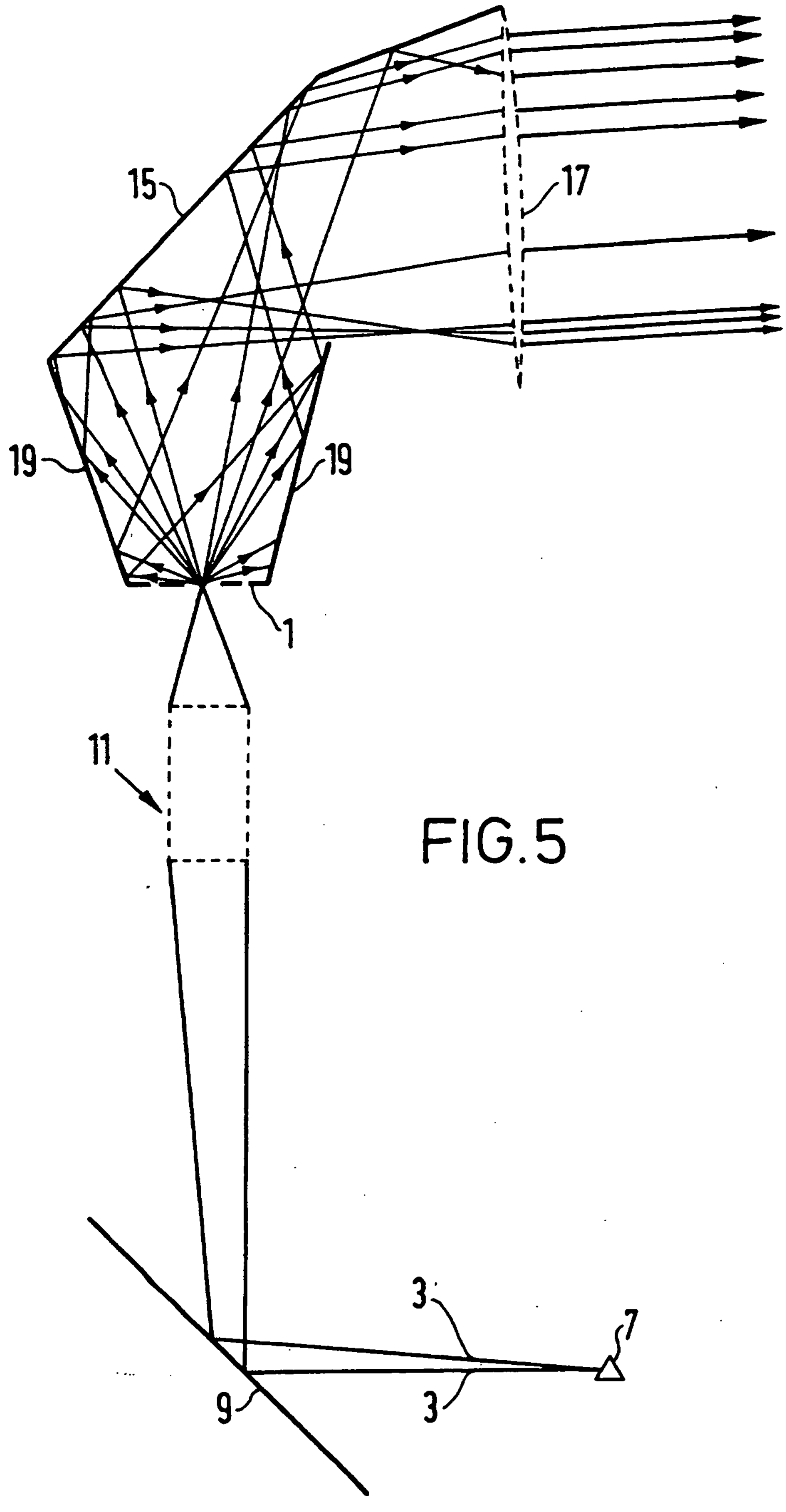

FIG.5

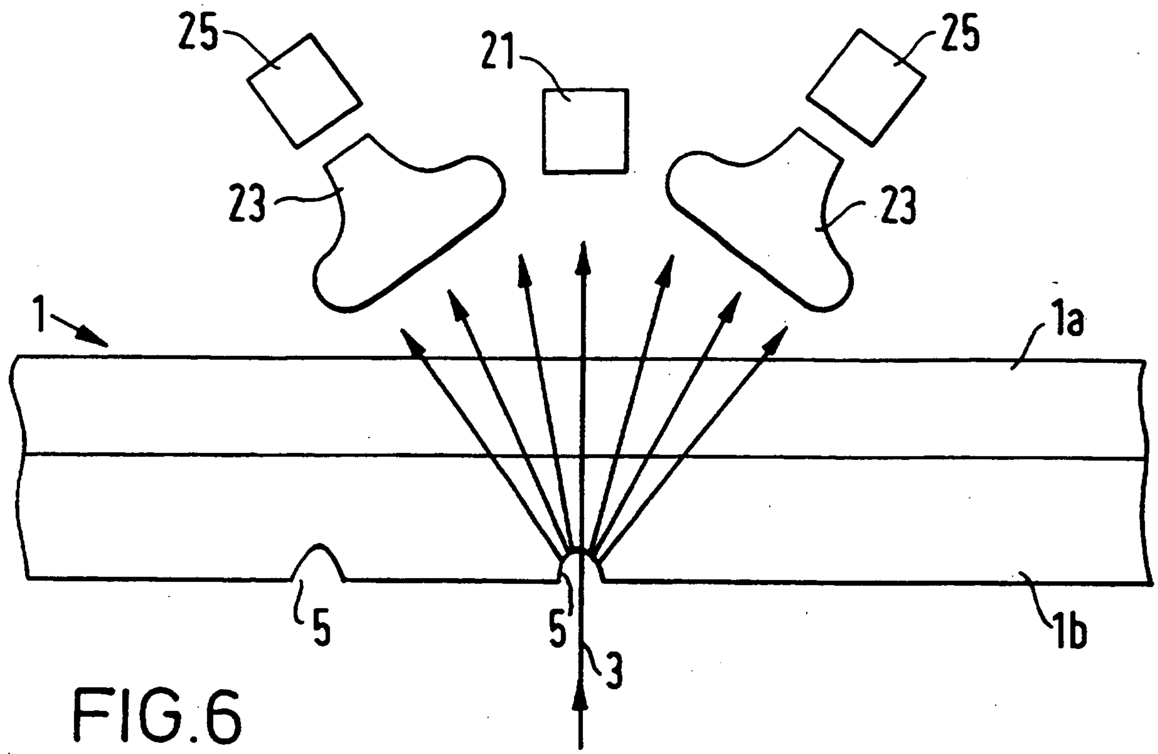

FIG.6

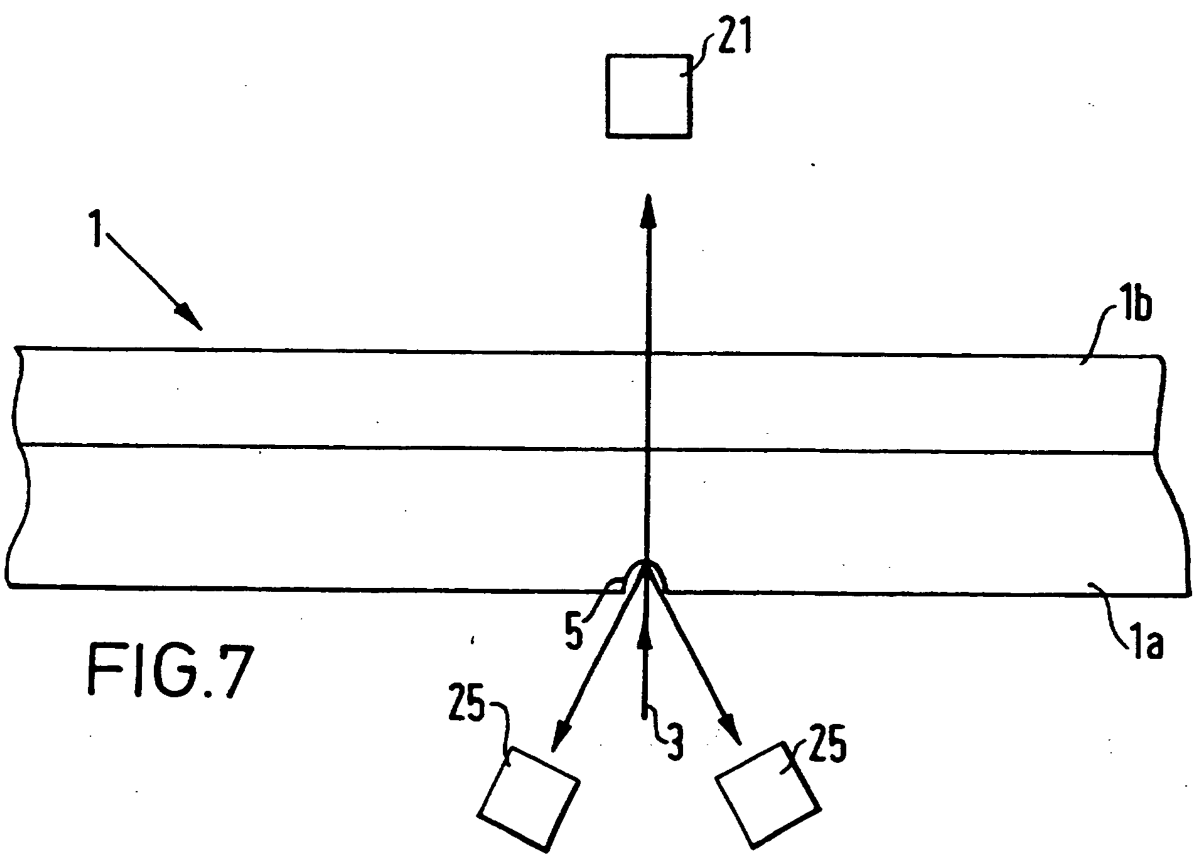

FIG.7

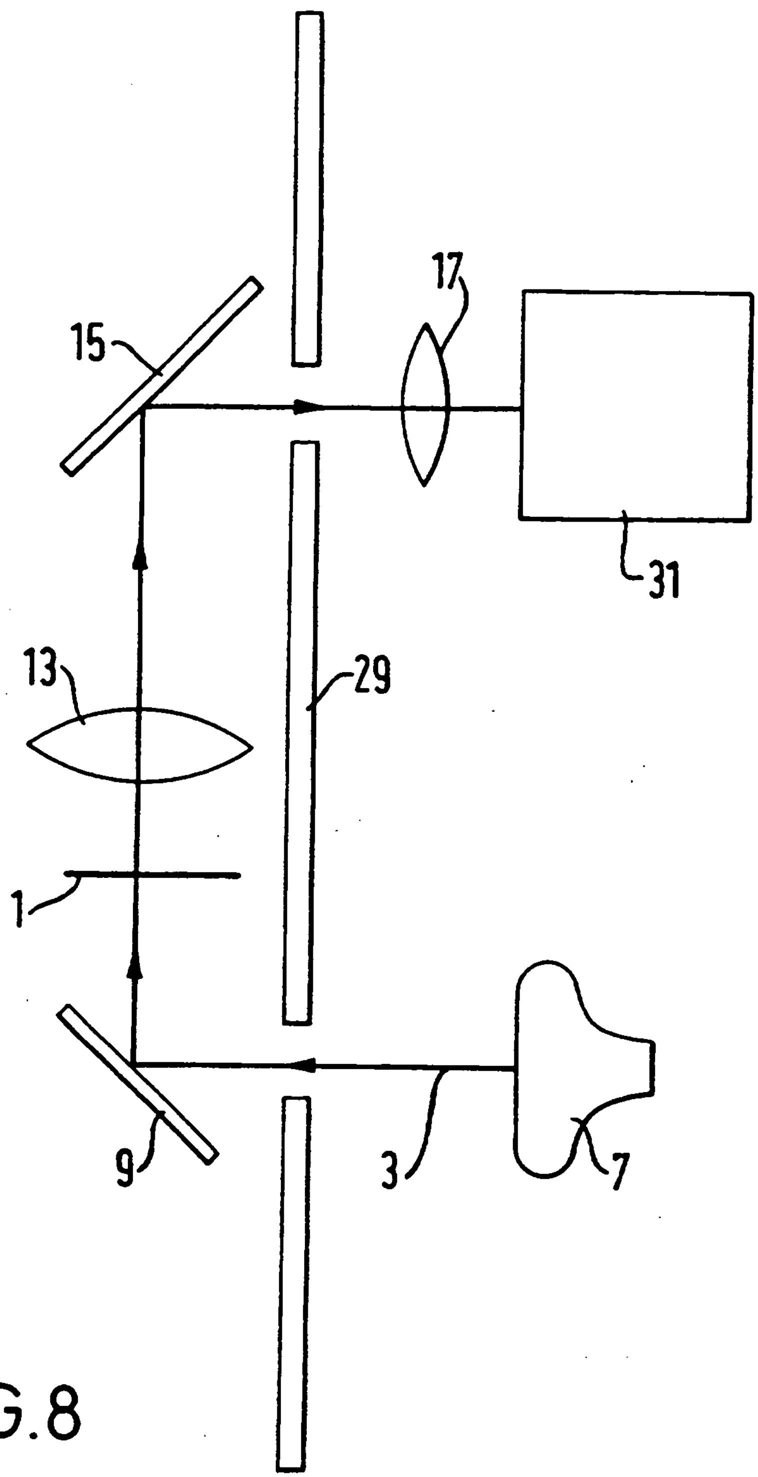

FIG.8

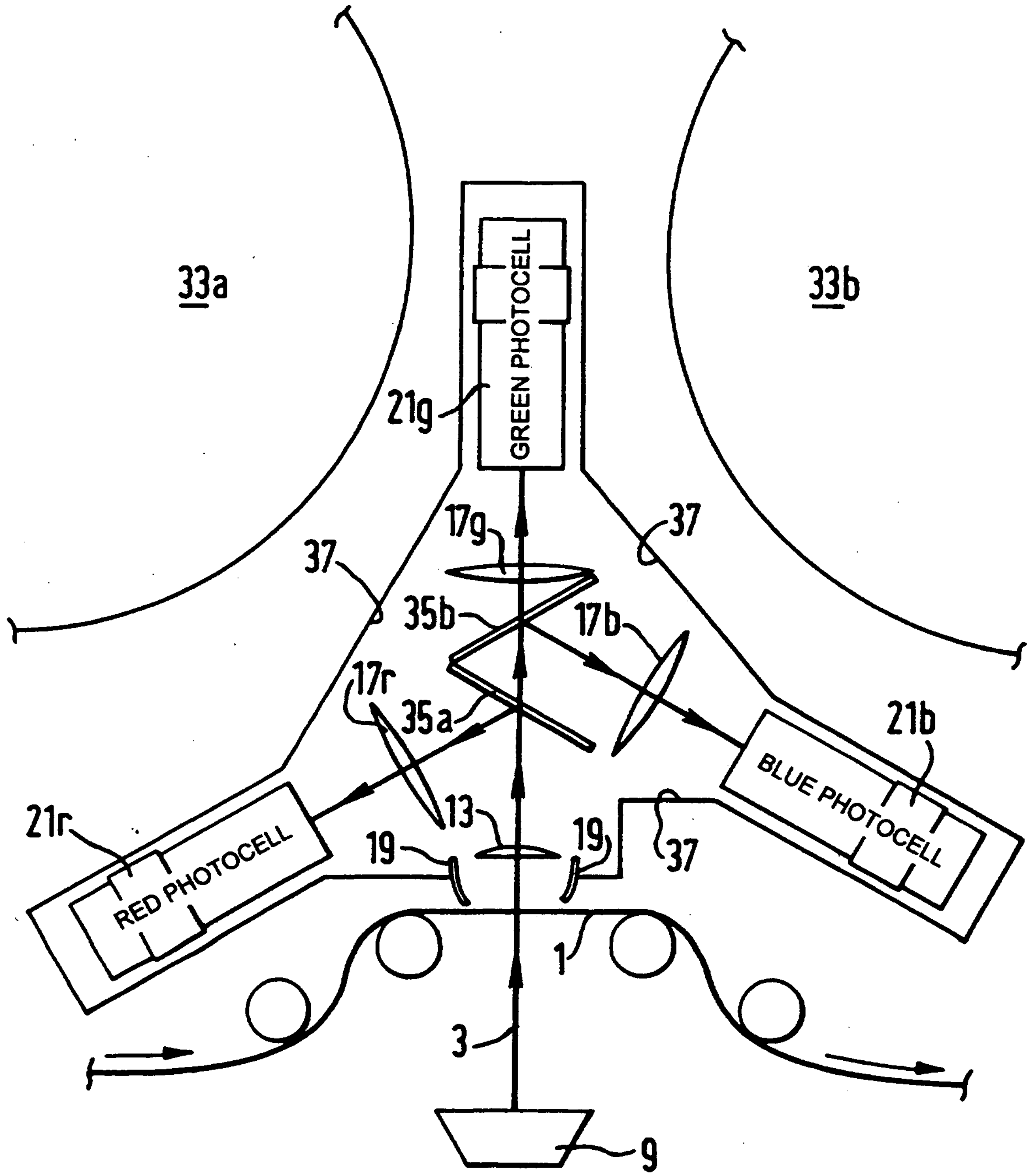
33a
33b
GREEN PHOTOCELL
21g
17g
37
35b
17b
37
17r
35a
21b
BLUE PHOTOCELL
21r
RED PHOTOCELL
13
19
19
37
1
3
9

FIG.9

TELECINE SYSTEMS

The present invention relates to the optical scanning of photographic, in particular cinematographic, film to produce electrical signals corresponding to the images stored on the film, for example for television pictures or video recordings.

Machines to produce such electrical signals from motion picture film, generally referred to as "telecine machines" have been known for many years. References indicate that such a process was known in the 1920's and used by John Logie Baird. Examples of current telecine machines include the "URSA Diamond" manufactured by Cintel International Ltd. of Ware, Hertfordshire, and the "SPIRIT Datacine" from Philips of Darmstadt, Germany.

A problem that exists in the use of such machines concerns the visibility in the final television or video image of damage on the original film. Cinematographic film is very fragile, and the emulsion layer which carries the image can be easily damaged in use by particles of dust, handling, friction, abrasion, and in other ways. Damaged areas of the film are immediately noticeable to the eye as light incident on the damaged region is scattered by the uneven surface of the film at that point and the consequent difference in the effective thickness of the film.

Many methods are used to minimise the effect of damage on the video images obtained from film. One widely known technique involves the use of a so-called 'wet gate'. Such systems are made by Peterson of Wheeling, Illinois, USA. According to this technique the film is not scanned in air, as would be the normal case, but in a glass tank filled with a liquid of the same optical refractive index as the film emulsion. Thus, the optical effect of the liquid is to fill the

scratch, thereby preventing scattering of the light at damage sites, as the film and liquid form an optically continuous medium of constant refractive index.

These wet gate methods are fraught with difficulty. One problem is that the most widely used liquid of the correct refractive index is perchlorethylene, a known carcinogen. The containment of the liquid in the tank is a second issue that causes difficulty. It is usual for the film to pass through rubber squeegees. These rubber blades act as wipers that rub the fluid off the film. However, the blades inevitably cause damage to the film, such that a slightly damaged film which is passed through the wet gate will generally only be suitable for further use on other wet gate systems as its condition will be worsened by the wet gate process. A further feature that makes the wet gate process undesirable is that the liquids used in wet gates often act as solvents. Thus, the materials that are used inside the tank must be tested to ensure that they will not be damaged by the fluids used. Additionally, the fluids used in wet gates are often flammable, thus making their use highly undesirable.

Other techniques used to minimise the visibility of film damage include methods that illuminate the film with diffuse light. Such known methods include the use of so-called 'integrating cylinders'. For example, US patent 4,868,383 discloses a linear light source for a film scanner including means for generating an intense beam of light and an elongated cylindrical integrated cavity having diffusely reflective walls, and defining an input port through which the intense beam is introduced into the cavity and an output slit parallel to the long axis of the cylindrical integrating cavity to emit a uniform line of light.

US patent 5,241,459, also discloses an integrating cylinder for use as an illuminator for a film scanner.

Both of these methods suffer from difficulties

involved in the manufacture of these integrating cylinders, which are very costly to produce, and inevitably have some variation in the evenness of light emitted across the slit.

US patent 4,937,614 teaches the use of an anisotropic diffusing lens disposed between the transparent original and the light source for diffusing light only in one direction for the case where the defects are scratches running along the length of the film. Yet again the manufacture of such anisotropic diffusing elements poses many practical problems.

According to an invention disclosed herein there is provided apparatus for the scanning of cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, the apparatus comprising collecting means for redirecting light scattered by damage to the surface of the film towards a photodetector.

The applicant has realised that in conventional scanning systems with point light illumination, because scattered light is not collected, the scratched and damaged areas are visible in the final image, as less light is collected from these regions. Thus, in accordance with the invention, rather than scanning the film with diffuse light and collecting it at a point detector, the film may be illuminated with light from a point source and the scattered light from the damaged film may be collected. In this way, the visibility of damage to the film to be scanned, in particular to the emulsion thereof, in the resultant electrical image may be reduced.

Thus, according to an invention disclosed herein there is provided a method of compensating, during the scanning of cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, for the effect of damage to the surface of the film, wherein light is applied to the

film along an optical axis substantially perpendicular to the plane of the film and the light scattered by damage to the surface of the film is detected, in addition to the light transmitted by the film along the optical axis.

Preferably, the collecting means is arranged to redirect all of the light scattered by damage to the film to a photodetector, although this is not essential, as it has been found that even if only a proportion of the scattered light is detected, significant improvement to the quality of the electrical image is possible.

The collecting means may be reflective or refractive. For example, plane or curved mirrors may be used to direct scattered light towards a photodetector. Preferably, such a mirror or mirrors is/are arranged to optically enclose the scattered light so that it can only travel towards the photodetector. In this case, a conical or frusto-conical mirror is preferred, although a similar effect could be achieved by an arrangement of plane mirrors in a conical or frusto-conical arrangement of polygonal cross-section or by a bowl-shaped mirror.

Refractive collecting means may be, for example, optical fibres, preferably arranged in a flared bundle such that the ends of the fibres at the wider end of the bundle collect the scattered light and direct it to a photodetector at their other ends. A suitable refractive collecting means would be a lens, for example a fresnel lens or an aspheric condenser, of sufficient extent to capture the scattered light.

The photodetector may be a single main photodetector, such as a photomultiplier or a plurality of photomultipliers, arranged to receive both un-scattered light transmitted by the film and scattered light directed to the photodetector by the collecting means. A plurality of photodetectors may each be arranged to receive light corresponding to colour components of the light transmitted by the film.

Alternatively, one or more additional photodetectors may be provided in addition to the main photodetector receiving un-scattered light, which additional photodetectors receive and detect the scattered light. Such additional photodetectors will generally be arranged off the optical axis of the optical system of the apparatus.

Thus, according to an invention disclosed herein there is provided apparatus for scanning cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, the apparatus comprising a main photodetector arranged on an optical axis perpendicular to the plane of the film for receiving light transmitted by the film, and at least one additional photodetector arranged off the optical axis for receiving light scattered by damage to the surface of the film.

The additional photodetector(s) may be arranged on the same side of the film as the main photodetector in order to receive light scattered on transmission through the film, or the additional photodetectors may be arranged on the opposite side of the film to the main photodetector in order to receive back-scattered light from the film. Of course, both of these arrangements may be used simultaneously. Collecting means may be provided to direct the scattered light to the additional photodetectors.

The electrical signals from the additional photodetectors registering transmission scattering may be added into the electrical signals from the main photodetector. Alternatively, the electrical signals from the additional photodetector may be used as an index of the amount of scattered light, with the electrical signals from the main photodetector boosted accordingly. In the case of an additional photodetector(s) registering back-scattered light the electrical signals from this detector may be used to

compensate the electrical signals from the main photodetector for loss of the scattered light. In addition, the electrical signals relating to the scattered light may be used to derive a quality parameter for the film. The processing of the electrical signals from the various photodetectors may be achieved in the analogue or digital, after suitable conversion, domains.

According to an invention disclosed herein, there is provided a method of processing cinematographic film to produce electrical signals corresponding to the amount of light transmitted by the film, wherein light is applied to the film along an optical axis substantially perpendicular to the plane of the film; light transmitted by the film is converted to a first electrical signal by a first photodetector positioned on the optical axis; light scattered by imperfections in the film is converted to a second electrical signal by a second photodetector; and the first electrical signal is compensated for the effect of the scattered light with reference to the second electrical signal.

According to an invention disclosed herein there is provided a method of scanning cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, in which a primary optical system is arranged such that transmitted light within a first cone of scattering of the light by the film is detected, and a secondary optical system is provided to detect light lying within a second cone of scattering of the light by the film and outside of the first cone, so as to compensate for excessive scattering due to damage to the film. The secondary optical system may be distinct from the primary optical system, for example to the extent of comprising secondary detection means to detect light which does not pass through the primary optical system to primary detection means. Alternatively, the secondary system may collect light

which is escaping from the primary optical system and may redirect it back into the primary system for detection by the primary detecting means.

According to a further development of the invention, the optical path from the film to the photodetector(s) may be substantially enclosed by a reflective enclosure. In this way, the light transmitted by the film can only be absorbed by the photodetector, because no other light-absorbing surfaces are provided along the optical path. Thus, according to an invention disclosed herein, there is provided apparatus for converting cinematographic film to corresponding electrical signals, wherein the optical path from the film to at least one photodetector is substantially enclosed by an enclosure having an optically reflective inner surface.

In addition, it is desirable for the optical path between the film and the photodetector(s) to be as short as possible so that less opportunity is provided to the light to scatter or be absorbed.

Thus, according to an invention disclosed herein, there is provided apparatus for the conversion of cinematographic film to corresponding electrical images, the apparatus having a direct linear path from the film to at least one photodetector for light transmitted by the film. In this way, the optical path from the film to at least one photodetector is not bent by mirrors, and thus light is not absorbed by the mirrors, which in practical systems are less than perfect reflectors. Furthermore, a compact arrangement of the photodetector apparatus can be provided.

The apparatus may comprise more than one photodetector, for example one photodetector for each of a plurality of colour components of the light transmitted by the film, such as red, green and blue. A chromatically selective beam splitter, such as a dichroic mirror, may be provided in the linear path to

divert a predetermined colour of light towards a further photodetector while allowing the remainder of the light to pass undiverted along the linear path.

In a particularly preferred arrangement, three photodetectors are provided. A first photodetector is aligned with the linear path for directly receiving light transmitted by the film. The second and third photodetectors are arranged with their axes at an angle to the linear path. The second and third photodetectors may be disposed at opposite sides of the linear path. In a most preferred arrangement, the photodetectors are arranged substantially in an inverted Y-shape with the linear path aligned with the stem of the Y. This arrangement is particularly preferred as it allows the first photodetector to be positioned between the reels of a telecine machine, with the second and third photodetectors below the reels. This allows the apparatus to be fitted to the front of a deck plate of a telecine machine, such as a machine of the URSA series manufactured by Cintel International Limited of Ware, U.K.

Thus, according to an invention disclosed herein, there is provided apparatus for the conversion of cinematographic film to corresponding electrical signals comprising first, second and third photodetectors, wherein the first photodetector is provided on a linear optical path substantially normal to the film plane, and a first dichroic mirror is provided in said linear optical path to divert a colour component of light transmitted by said film to said second photodetector and a second dichroic mirror is provided in said linear optical path to divert a further colour component of light transmitted by said film to said third photodetector.

The invention also extends to a telecine machine in combination with the described apparatus.

Some embodiments of the invention will now be

described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a light ray passing through a section of undamaged film;

Figure 2 is a schematic view of a light ray passing through a section of damaged film;

Figure 3 is a view of the optical path in a conventional telecine machine scanning a section of undamaged film;

Figure 4 is a schematic view of the optical path in a conventional telecine machine scanning a section of damaged film;

Figure 5 is a schematic view of the optical path in a telecine machine according to an embodiment of the invention scanning a section of damaged film;

Figure 6 is a schematic view of a light ray passing through a section of damaged film in a telecine machine according to a further embodiment of the invention;

Figure 7 is a schematic view of a light ray passing through a section of damaged film in a telecine machine according to yet a further embodiment of the invention;

Figure 8 is a schematic view of the optical path in a conventional telecine machine relative to the deck plate thereof; and

Figure 9 is a schematic view of a yet further embodiment of the invention.

Figure 1 shows a portion of cinematographic film 1 undergoing a scanning process in a telecine machine. The film 1 is composed of a backing layer 1a, usually of cellulose material, and an emulsion layer 1b. The backing layer 1a provides the film with its physical strength and the emulsion layer 1b contains the picture information in the form of regions having differing light transmission characteristics.

The telecine machine operates in a known manner by directing a focused beam of light at a small region, or "pixel", of the film 1 from one side of the film and

capturing the light transmitted by the film 1 at the other side by means of a photodetector. The photodetector detects the amount of light transmitted by the region of the film and converts this amount to a corresponding electrical signal. In the case of colour film, a plurality of photodetectors may be arranged to receive the light transmitted by the film, each photodetector detecting the amount of a particular colour component of the transmitted light, for example red, green or blue, and producing a corresponding electrical signal. The beam of light is scanned over the whole surface of a film frame such that an array of electrical signals corresponding to the transmission of the film frame at each pixel is produced. In this way, the image stored on the film is converted to corresponding electrical signals.

In general, the film 1 is arranged in a so-called "gate" such that the light beam is normally incident on the film surface. This prevents bending of the light at the interface between the film and the surrounding air. It is also usual for the film 1 to be arranged such that the light is first incident on the emulsion layer 1b, as shown. However, it is also possible for the film 1 to be scanned with the light initially incident on the backing layer 1a.

As can be seen from Figure 1, in the case of undamaged film 1, a light ray 3 passes straight through the film 1 without any change in its direction. The amplitude and colour content of the ray will of course be modified by the transmission characteristics of the emulsion layer 1b.

Figure 2 shows a situation similar to Figure 1. However, in this case the emulsion layer 1b of the film 1 has been damaged and as a result contains indentations 5. These indentations may be, for example, scratches on the emulsion layer 1b. As can be seen, light ray 3 is no longer normally incident on the emulsion layer 1b, as

the surface of the indentation 5 is not parallel to the rest of the surface of the emulsion layer 1b. Thus, as the light passes from the surrounding air into the emulsion layer, the change in refractive index causes the light to bend, dependent on the angle of incidence of the light 3 on the surface of the indentation 5. The effect of the irregular surface of the indentation 5 is that scattered light emerges from the backing layer 1a of the film. Because the light is scattered in a large number of directions, a proportion of the transmitted light will not reach the photodetector, which is arranged to receive light passing undeviated through the film 1. Thus, the photodetector will register a lower transmission for the scratched portion of film than is actually the case, and the scratch will appear darker on the final converted electrical image. In fact, the scratch should appear lighter than the surrounding image as a portion of the emulsion layer 1b has been removed in forming the indentation 5, and thus the attenuation capability of this portion of the emulsion 1b has been reduced.

Figure 3 shows the optical path in a known telecine machine based on the popular URSA telecine machine manufactured by Cintel Ltd., of Ware, Hertfordshire, England. However, the invention may be applied easily to other designs of telecine.

According to this figure, light source 7 produces light 3 which is reflected by a mirror 9. The light 3 passes through a gate focus arrangement 11 which focuses the light onto the cinematographic film 1, which in this case is not damaged, and therefore does not scatter the light. The light transmitted by the film 1 is collected by a lens 13, which directs the light onto a further mirror 15. The mirror 15 directs the light through a collecting lens 17, and onto a photodetector (not shown). The mirrors 9 and 5 in this arrangement merely serve to fold the light path in order to produce an

optical assembly that is compact, but nevertheless has a long optical path.

Figure 4 shows the effect of imperfect film being illuminated in the optical system of Figure 3. The film 10 is physically damaged, such as shown in Figure 2, and thus the film 1 scatters the light incident upon it.

Consequently, some light will be scattered at such a large angle that it will not be collected by the lens 13 and will therefore not be directed by the mirror 15 and collecting lens 17 to the photodetector. Even scattered light that is collected by the lens 13 may not be converged to a sufficient extent that it will be collected by collecting lens 17. This light will also be lost. In Figures 3 to 5, the light source 7 is a so-called "flying spot" of a cathode ray tube. This spot is moved, in a known manner, in a raster pattern, i.e. a series of closely spaced parallel lines, so that it scans the whole area of the film frame. The resultant scan of the film image 10 is a two-dimensional array of points or pixels that approximate to the continuous transmission values of the film image.

Thus, when the point being sampled is undamaged, the situation is as in Figure 3, and all of the light transmitted through the film is collected by the photodetector. However, when the scanning spot is incident on a point where there is damage to the film, the situation is that shown in Figure 4. Thus even if the first point to be sampled and the second point to be sampled have equal densities, i.e. transmission characteristics, and should therefore appear identical, the damaged area will be reproduced differently, as light is being scattered such that some of it is not collected, resulting in a different signal produced by the photodetector.

Figure 5 shows the optical path of Figure 4 adapted in accordance with the invention. In this embodiment the lens 13 is replaced by a conical mirror 9 which

collects the light that would otherwise be scattered and lost and recombines this scattered light with the rest of the transmitted light. This Figure shows a section through the optical path, and thus the conical mirror 19 shown is actually a continuous frusto-conical shell. Collection of the light that would have been lost to the photodetectors by scattering using the conical mirror 19 ensures that damaged areas of the film 1 are reproduced in a similar manner to areas of undamaged film of equal density.

The conical mirror 19 shown in Figure 5 ensures that all of the light scattered by film damage is directed to the photodetector. However, it has been found that any arrangement that redirects only some of the scattered light to the photodetector exhibits a significant improvement in the quality of the resultant images over known systems. Thus, it is not necessary for a mirror such as the conical mirror 19 to completely circumscribe the film frame 1. Indeed, in situations where the damage to the film is in the form of scratches running parallel to the transport direction of the film, mirrors may only be required parallel to this direction, as most scattering will occur in direction perpendicular thereto.

Figure 6 shows a schematic view of a further embodiment of the present invention. In this case, the light scattered by the damage 5 to the film 1 is collected, not only by a single photodetector 21 such as is already used in known systems, but also by two bundles of optical fibres arranged symmetrically about the optical axis 23. The bundles of optical fibres 23 direct the scattered light to additional photodetectors 25 which convert the received scattered light levels to electrical signals. The electrical signals corresponding to the scattered light may then be added, in the analogue or digital domains, to the signal from the main photodetector, so as to achieve a resultant

electrical signal corresponding substantially to the total light transmitted by the film 1. Alternatively, the electrical signals from the additional photodetectors 25 may be used as a compensation signal indicating the degree of scattering occurring at a particular point. The signal from the main photodetector may then be boosted accordingly. Thus, by this alternative method, after calibration, it is not necessary to capture all of the scattered light, as the level registered by the additional photodetectors 25 will be representative of the degree of scattering. In the above embodiment, the fibre optic bundles 23 are not essential, as an improvement in resultant signal quality will be achieved simply by using the additional photodetectors 25 on their own.

According to a further embodiment of the invention, shown in Figure 7, scratches and damage on the front, i.e. backing film 1a, surface of the film 1 are compensated. In this embodiment, the orientation of the film 1 is reversed compared to the preceding embodiments. Thus the light 3 is initially incident on the backing layer 1a of the film 1. The effect of damage 5 to the backing layer 1a is that light is back-scattered, i.e. reflected, from the point of damage rather than scattered on transmission, i.e. by refraction, as is the case with damage to the emulsion layer 1b. Thus, damage to the backing layer 1a of the film loses light irretrievably. The calculation of the film density is therefore incorrect, as not all of the light even enters the film, and the assumptions made in measuring the amount of light transmitted by the film are incorrect. However, in this embodiment, additional photodetectors 25 are provided to measure the amount of back-scattered light. From this, a measure of the amount of light entering the film can be obtained and knowing, from the signal photomultiplier, the amount of light that exits the film 1, the actual density of the film

can be calculated. This process makes scratches less visible in the resultant electronic image, as the density error caused by back-scattering causes signals from this area to be incorrect so that they appear as discontinuities relative to the neighbouring areas.

Figure 8 shows schematically the optical path of Figure 3 in relation to the deck plate 29 of a conventional URSA telecine machine. The deck plate 29, shown in section in Figure 8, is the component of the telecine machine relative to which other components are fixed. The deck plate is tilted at around 15° to the vertical so that the upper edge of the plate 29 is further away from the telecine operator than the lower edge.

As shown in Figure 8, the light beam 3 (or flying spot) is produced by a light source 7, in the form of a cathode ray tube, behind the deck plate 29. The light beam 3 passes through an aperture in the deck plate 29 and is deflected by mirror 9 towards the film 1. For reasons of simplicity, the gate focus arrangement 11 of Figure 3 is not shown in Figure 8. Having passed through the film 1, the light beam 3 is focused by a lens 13 and then deflected by a mirror 15 back through a further aperture in the deck plate 29 towards the detector 31, via a further lens 17. The detector 31 comprises photomultipliers and dichroic mirrors to split the light beam 3 into its component colours (red, green, blue) and detect each colour.

Figure 9 shows an apparatus according to an embodiment of the invention mounted to the deck plate 29 described in relation to Figure 8. The view of Figure 9 is a front view relative to that of Figure 8 which is a sectional view from one side. The apparatus shown in Figure 9 replaces the mirror 15, lens 17 and detector 31 of Figure 8.

According to this embodiment of the invention, the light beam 3 from the light source 7, once deflected by

the mirror 9, passes through the film 1. A gate focus arrangement 11 as described in relation to Figure 3 may be provided in this embodiment, but is not shown in Figure 9. As shown partially in Figure 9, the film 1 is provided from a feed reel 33a, fixed relative to the deck plate 29, through a series of rollers to the scanning position and then to a take-up reel 33b also fixed relative to the deck plate 29. The apparatus of this embodiment fits conveniently between the film reels 33a,33b on the deck plate 29.

Once the light beam 3 has passed through the film 1, any light scattered by damage to the film is directed towards the focussing lens 13 by curved mirror 19, shown in section in Figure 9. The curved mirror 19 encloses the light beam 3 in order to collect as much as possible of any scattered light. Once the light has passed through the focussing lens 13, it is incident on a first dichroic mirror 35a, which reflects red light towards a photodetector 21r via a lens 17r, but allows blue and green light to pass undeviated. The blue and green light is then incident on a second dichroic mirror 35b which reflects the blue light towards a photodetector 21b, via a lens 17b, while allowing the green light to pass undeviated to a photodetector 21g, via a lens 17g. The lenses 17r, 17g and 17b may be fresnel lenses. Thus, it will be seen that the apparatus of the embodiment provides a much more compact optical path than that of the conventional telecine machine shown in Figure 8, such that less light is lost along the optical path than is the case with the conventional machine. In particular, it has been found that in practical systems a loss of light equivalent to a 1 dB drop in the signal to noise ratio occurs each time the light beam 3 is deflected by a mirror, as even the best mirrors are not perfect reflectors of light. In the apparatus of this embodiment, the mirror 15 of the conventional arrangement shown in Figure 8 is not required and thus

the light loss associated with that mirror does not occur.

In an enhancement of this embodiment, the inner surfaces 37 of the apparatus are provided with a reflective coating, rather than a conventional matt black coating, in order that any scattered light will be reflected back into the body of the apparatus to be detected by one of the photodetectors, 21r, 21g, 21b. Even though the scattered light reflected by the walls 37 of the apparatus may not be detected by the appropriate photodetector to its colour, it has been found preferable, in terms of the visual effect of the final electronic image, for as much light as possible to be detected and converted to electrical signals, regardless of whether the derived electrical signals completely accurately represent the colour composition of the light transmitted by a particular portion of the film 1. In other words, if scattered light is lost to the photodetectors, detail will be lost in the final electronic image, but by collecting as much scattered light as possible this detail can be maintained, even if not in the correct colour composition. Slight artefacts in colour composition can be corrected electronically in the final electronic images, but it is much more difficult to add missing detail.

Claims

1. Apparatus for the scanning of cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, the apparatus comprising collecting means for redirecting light scattered by damage to the surface of the film towards a photodetector.

2. Apparatus as claimed in claim 1, wherein the collecting means is reflective.

3. Apparatus as claimed in claim 2, wherein the collecting means is arranged to optically enclose the scattered light.

4. Apparatus as claimed in any preceding claim, wherein the photodetector is arranged to receive both scattered light redirected by the collecting means and light which has not been scattered.

5. Apparatus as claimed in any of claims 1 to 3, comprising a further photodetector for detecting light which has not been scattered.

6. Apparatus for scanning cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, the apparatus comprising a main photodetector arranged on an optical axis perpendicular to the plane of the film for receiving light transmitted by the film, and at least one additional photodetector arranged off the optical axis for receiving light scattered by damage to the surface of the film.

7. Apparatus for the conversion of cinematographic film to corresponding electrical images, having a direct

linear path from the film to at least one photodetector for light transmitted by the film.

8. Apparatus as claimed in any preceding claim, wherein internal surfaces of the apparatus enclosing the optical path between the film and at least one photodetector are provided with a reflective surface.

9. Apparatus for converting cinematographic film to corresponding electrical signals, wherein the optical path from the film to at least one photodetector is substantially enclosed by an enclosure having an optically reflective inner surface.

10. Apparatus for the conversion of cinematographic film to corresponding electrical signals comprising first, second and third photodetectors, wherein the first photodetector is provided on a linear optical path substantially normal to the film plane, and a first dichroic mirror is provided in said linear optical path to divert a colour component of light transmitted by said film to said second photodetector and a second dichroic mirror is provided in said linear optical path to divert a further colour component of light transmitted by said film to said third photodetector.

11. A method of compensating, during the scanning of cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, for the effect of damage to the surface of the film, wherein light is applied to the film along an optical axis substantially perpendicular to the plane of the film and the light scattered by damage to the surface of the film is detected, in addition to the light transmitted by the film along the optical axis.

12. A method of processing cinematographic film to produce electrical signals corresponding to the amount of light transmitted by the film, wherein light is applied to the film along an optical axis substantially perpendicular to the plane of the film; light transmitted by the film is converted to a first electrical signal by a first photodetector positioned on the optical axis; light scattered by imperfections in the film is converted to a second electrical signal by a second photodetector; and the first electrical signal is compensated for the effect of the scattered light with reference to the second electrical signal.

13. A method of scanning cinematographic film to produce electrical signals characteristic of the amount of light transmitted by the film, in which a primary optical system is arranged such that transmitted light within a first cone of scattering of the light by the film is detected, and a secondary optical system is provided to detect light lying within a second cone of scattering of the light by the film and outside of the first cone, so as to compensate for excessive scattering due to damage to the film.

14. Apparatus adapted to carry out the method of any of claims 11 to 13.

15. A method of converting cinematographic film to corresponding electrical signals substantially as hereinbefore described with reference to the accompanying drawings.

16. Apparatus for converting cinematographic film to corresponding electrical signals substantially as hereinbefore described with reference to the accompanying drawings.

Application No:	GB 9805715.1	**Examiner:**	John Donaldson
Claims searched:	1 to 6, 9, 11 to 14, also claim 8 as appendant to claims 1 to 6	**Date of search:**	16 July 1998

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1409153	(BBC), see page 1, line 58 to page 2, line 50	1, 5, 6, 11 to 14
X	WO 83/02869 A1	(KODAK), see page 1, lines 2 to 13, page 3, line 31 to page 6, line 35	1 to 4, 8, 9, 11, 14
X	US 4481414	(GASPER), see column 4, lines 21 to 37, column 7, line 39 to column 10, line 18	1 to 4, 8, 9, 11, 14

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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